NOTES ON PROSOBRANCHIATA.

No. ii.—*LITTORINACEA.*

By H. Leighton Kesteven.

(Plate xxx.)

When studying the affinities of *Fossarina* (9), I found that *Risella* differed in anatomic characters from *Littorina*, the type genus of the family, to which, in the past, it has been assigned. I have since studied its anatomy from actual dissections and from sets of serial sections, kindly prepared for me by Messrs. J. P. Hill and R. Greig Smith. My thanks are also due to Mr. C. Hedley for many useful suggestions. I have also dissected *Tectarius* and *Littorina*. As a result of comparing the anatomy of these with other Tænioglossa, I have found it advisable to reclassify the Littorine groups thereof. It will be as well to state my conclusions first and discuss them in detail afterwards.

I have taken as my base Fischer's classification (4, pp. 707-711), and have altered it in the following manner :—

Superfamily LITTORINACEA.

Family LITTORINIDÆ.*

Containing those genera enumerated hereunder by Fischer, with the exception of *Fossarina* (which in my paper above referred to has been shown to be a *Trochid*), *Risella* and *Echinella*.

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* In defining Littorinidæ thus I have had to take a good deal for granted, since there have been no dissections of several of the genera published; nor have I been able to study the soft parts of any but Australian members. I have been unable to obtain even the shells of some of the genera. It is probable that, as our knowledge of Prosobranchiate anatomy increases, several of them will have to be removed.

Family RISELLIDÆ.

Genera *Risella*, Gray, and *Rissellopsis*, Kesteven.

Family MODULIDÆ.

Genera *Modulus*, Gray, *Echinella*, Swainson, and *Peasiella*, Nevill.

Family NASSOPSIDÆ.

Genus *Nassopsis*, Smith.

Reviewing the superfamily as a whole, its anatomic characters are—1, a much aborted osphradium; 2, simple branchiæ; 3, a rather large development of the mucous gland; 4, small salivary glands; 5, a large buccal mass; and 6, a long and practically uniform radula. To these may be added a general similarity of digestive tract and nervous system, and the absence of an introvert. Their habitat has been the indicator which led to the inclusion of these families under one designation. It seemed reasonable to expect that a station such as that occupied by *Littorina* should have had a modifying effect on some of the organs. It is to this that I would assign the degenerate osphradia and branchiæ, and perhaps also the large development of the mucous gland. Living so much out of water, the first of these organs would be of little use to the mollusc, and has accordingly become aborted. In *Tectarius nodulosus*, Gmel. (which in New South Wales lives beyond the reach of even spray, except in rough weather), the osphradium is so simple that, functionally, it must be almost impotent. The simplicity of the branchiæ is, I would suggest, due to the same cause. The large supply of mucus may possibly, by being deposited around the operculum, serve to seal the closure of the shell, and thereby prevent evaporation.

These three characters are constant throughout the superfamily; yet, if the extent of their development or abortion may be accounted for by "environment," we are at once presented with the question, are they characters of systematic importance? That these characters are the result of environment is a matter of opinion, but in the present instance they may bear weight as

forming part of a general similarity of organisation. Returning to the osphradium, Pelseneer (16) has said :—"Il constitute alors (dans les Ténioglosses les plus archaïque, exemple *Paludina*, *Littorina*, *Cyclostoma*, *Vermetus*, etc.), un bourrelet épithélial filiforme, sur un nerf ou sur un ganglion." While not contesting that this type of osphradium is archaic, I would point out that in some instances it may be a degenerate form. For instance, concomitant with a habitat such as that affected by *Littorina*, *Tectarius*, etc., there would necessarily be a disuse of this organ, a condition favourable to degeneration. The presence of an osphradium in a mollusc endowed with a pulmonary cavity would seem to mark such as an evolving Pulmonate rather than an archaic Tænioglossan.

Although somewhat foreign to the present paper, a short speculation on the use of the "glande pédieuse" of *Vermetus* may perhaps be allowable here. In the words of Lacaze Duthiers (10), the osphradium is here "reduit à un filet." The species of this genus are almost always covered by water, and, being fixed permanently in one position, it must be a vital necessity to test the quality of the water they inhale; and yet the osphradium, although strongly innervated, is very simple. It has occurred to the writer that it *may* be that the so-called pedal gland is a highly specialised olfactory organ; its free communication with the water would seem to support this view. It may be worthy of note that the analogue of such a pedal olfactory organ is to be found among the Pulmonata. That it is not a mucous gland seems certain from Lacaze Duthier's paragraph (10, 265):—"Une particularité bien digne d'intérêt s'est présentée. La glande placée dans la cavité du corps, qui s'ouvre entre le pied et la tête est, très probablement l'intermédiaire entre la cavité générale du corps et l'extérieur. Si donc il n'a pas été possible de découvrir ailleurs l'orifice extérieur de la circulation, on pourrait le considérer comme existant à la face inférieure de la glande." This explanation of its function seems untenable, since *Vermetus* is not capable of much expansion, and one would not, therefore, look to find a highly specialised aqueo-vascular orifice developed.

I would not be understood to advance this theory as a conviction; it is but a speculation of one who has not been able to examine the organ for himself; moreover, the osphradium cannot be regarded as functionless, for, as already mentioned, it is highly innervated.

Littorinidæ.

The family *Littorinidæ* has, at my hands, suffered only restriction. The reasons for removing the various genera therefrom will be found under the families in which I have placed them.

Risellidæ.

The family *Risellidæ* has been formed for the reception of the two unitypical genera *Risella* and *Risellopsis*.

I proceed at once to describe the anatomy of *Risella melanostoma*, Gmelin.

External features:—The mollusc extruded from its shell has been figured by Quoy and Gaimard (18), as also the operculum. The ground colour of the body is white, reticulated with black markings, which in places become confluent. Foot white, tinged with yellow. Operculum paucispiral, corneous, oval. The snout is not as long as it is represented in the figure referred to. Tentacles of medium length, carrying the eyes on prominences at their bases. When compared with *Littorina* or *Lotorium*, it is seen that *Risella* is twisted half round in its shell. In the former genera the dorsal aspect of the mollusc is that opposite to the axial, whilst in the latter, and most probably all genera possessing trochiform shells, the dorsal aspect is that which is uppermost when the shell is standing on its base. To make this more plain, when *Littorina* is set perpendicularly, with the spire up, the dorsal face of the mollusc is on the outside of the coils; with the shell of *Risella* in the same position the mollusc is lying with its dorsal face up. This twisting of the mollusc in the shell has resulted in the descending of the columellar muscle on to the base of the shell. In the following description I have spoken of

the dorsal as the superior, and the ventral as the inferior aspects of the mollusc.

The mantle is thin and transparent; through it may be seen, beginning from the left, the osphradium, branchiæ, mucous gland, rectum, and the uterus or vas deferens. Immediately posterior to the pallial cavity, and slightly to the left lies the nephridium. Below, posterior to the columellar muscle, the posterior œsophagus and anterior aorta may be seen through the thin connective wall, between the body and visceral coil. The genital gland lies over the superior surface of the visceral coil, covering the liver which constitutes the greater part of the coil; inferiorly the stomach may be seen. The branches from the aorta visceralis reticulate over both surfaces, but more profusely on the superior. Along the axis of the coil, for about half the length thereof, the posterior œsophagus may be seen; the main trunk of the aorta visceralis is also situated here, but extends to the end.

The osphradium (Pl. xxx., fig. 2, *osph.*) is extremely simple; a very narrow thread of epithelial tissue, nearly as long as the branchiæ, without any pectinations whatsoever; as already stated, it is but slightly innervated.

The branchiæ (fig. 2, *cten.*, and fig. 5) are more simple than in *Littorina*, the filaments being shorter and narrower. The fine thread-like prolongations found in that genus, *Lotorium*, *Natica*, etc., are here absent. These prolongations should, I think, be regarded as venous sinuses rather than as part of the ctenidium. In the species under consideration a large lacuna (fig. 5, *l.*) may be observed defining the anterior distal half of the organ. This is provided with such definite walls that it might well be regarded as a vein.

The mucous gland (fig. 1, *m.gl.*) is normally large; it lies alongside of the rectum, to the left, and starting a little behind the anus continues back to the end of the pallial cavity. It is of a grey colour, and consists of large cells of concentric structure. During fecundity the uterus, the walls of which secrete a great deal of mucus, seems to be developed somewhat at the expense of this organ.

The digestive tract (fig. 1) is esentially the same as in *Littorina*. The buccal mass (figs. 1 and 6, *buc.*) is large; the cartilaginous cushions on which the radula rides are shaped like the quarters of an orange, the thin or lower end of the large one on the right folding inside that on the left. There being no introvert, the anterior œsophagus (fig. 6, *ant. œs.*) is very short. It is provided with appendages (fig. 6, *app.*) similar to those figured by Souleyet in *Littorina* (21). The crop (figs. 1 and 6, *crop*) is the largest organ in the body cavity; it is of a brown colour, and, as in *Littorina*, the lumen is along its lower side; the greater part of it is traversed and divided by thin partitions, the attachment of which may be seen on the outside as slight constrictions. The posterior œsophagus (figs. 1 and 6, *post.œs.*) passes along the axis of the visceral coil for about half its length, when it enters the large, muscular-walled stomach (fig. 1, *st.*). This latter is shaped like a segment of a circle antero-posteriorly, and flattened dorso-ventrally; its distal end is a little posterior to the entrance of the œsophagus; anteriorly it tapers away to the thin intestine. The intestine (fig. 1, *int.*) immediately rises towards the superior face of the liver, and, having reached the surface, traverses that face of it to which the nephridium is attached, in the serpentine manner depicted in my figure; thence the rectum passes along the right side of the pallial cavity, the anus (fig. 1, *an.*) being situated well towards the end thereof. The liver is dark green, and, as is usual, is the main constituent of the visceral coil (fig. 1, *liv.*). The hepato-pancreatic ducts (fig. 1, *h.-p.d.*) are three in number—one at the extreme posterior end of the stomach, one emptying into the centre on the superior face, and the third situated well towards the anterior end, on the axial side. The position of this last may sometimes be seen from the outside. The salivary glands (figs. 1 and 6, *sal.gl.*) are small; their ducts enter the buccal mass on either side of and just anterior to the œsophagus. The radula (fig. 1, *rad.*) is typically littorinoid, long (46 mm.) and narrow; it leaves the buccal mass on the underside and passes to the right of the body cavity, where it is coiled up. The rachidian, as is stated in the

revised edition (1871) is incorrectly figured by Wilton in Woodward's 'Manual'; my figure (fig. 1) supplies this deficiency. I have counted over three hundred rows of teeth on the ribbon.

The nephridium (figs. 1, 2, 3, 4, *neph.*) is situated just behind the end of the pallial cavity, of which it, in part, forms the posterior boundary. It is slightly more on the left hand side than on the right. In the figures it has been detached from the liver, and laid back on the right hand side. The reno-pallial orifice is on the left hand side; its position is shown in figure (fig. 1, *r.b.o.*). The natural position of the nephridium is shown in the figures by the dotted line, but the line of the anterior attachment is shown only on fig. 4, by the double dotted line; from this it will be seen that there is a pocket of the organ overlying the pericardium. The reno-pericardial orifice is very small; its position is under the pocket just mentioned (fig. 4, *r.p.o.*).

Circulatory system (fig. 2):—The heart (fig. 2, *heart*; fig. 5) lies in the pericardium, immediately behind the ctenidium and in front of the nephridium, a pocket of which, as already mentioned, overlies it. It consists of a thin-walled auricle (fig. 5, *aur.*), well divided from a larger and thick-walled ventricle (fig. 5, *vent.*). The arterial system consists of a very short aortic trunk, which gives rise to the anterior and posterior aortæ. The former (fig. 2, *ant.aor.*) enters the body cavity alongside and slightly below the œsophagus, underneath which it passes, apparently without giving off any branches till the centre of the crop is reached, where a small branch, which bifurcates at once on the underside of that organ is to be seen. Continuing forward it suddenly diminishes just posterior to the pedal commissures and ganglia; the main branch here enters the foot. A smaller branch continues forward and supplies the head and buccal mass. The posterior aorta (aorta visceralis) almost at its inception, sends a branch to supply the liver, under the nephridium (fig. 2, *a.*). Further back another and rather larger branch arises which supplies the rectum, uterus, and right side of the mantle (fig. 2, *b.*). From this second branch the aorta passes through the liver, so far as I can ascertain, without branching till it reaches the

surface on the axial side, a little distance posterior to the nephridium (fig. 2, *c.*). From here it may, without dissection, be followed along the axis of the coil to the end, giving off branches all the way (fig. 2, *c.'*, *c.''*, *c.'''*); those given off superiorly are much the largest, and in some cases almost embrace the coil; the finer branches of these reticulate throughout the genital gland and liver.

There are only two veins, properly so called—the branchial (fig. 2, fig. 5, *br.v.*) and nephridial (fig. 2, *neph.v.*); the former is the larger, and enters the auricle almost immediately after leaving the branchiæ. The latter, although the smaller, is perhaps not less important; its branches reticulate over, and collect the blood absorbed through the wall of the nephridium, to discharge itself into the branchial vein just outside the pericardium. It seems probable that this vein supplies the new blood to the system. My sections show venous sinuses between the inner and outer wall of the mantle. Their presence was to be anticipated, considering the size of the artery supplying the right side of the mantle. From the ventricle through the right pallial artery, and pallial sinuses to the branchiæ, and back to the auricle, is then the shortest circuit. It was this that led me to suggest that the so-called "filiforme prolongations" of some branchiæ are really venous sinuses.

Nervous system (figs. 12, 13):—The main ganglia and their commissures only are here described and figured. So far as my dissections have gone, the system is essentially the same as in *Littorina*. It is hoped in a future paper to describe this part of the anatomy of *Risella* in more detail, and to compare it with the nervous systems of several of the other genera in the superfamily. The difficulty attendant on getting material for such a comparison has rendered it impossible to incorporate it in the present essay.

The cerebral ganglia (figs. 12, 13, *c.g.*) and their commissure are not at right angles to the antero-posterior axis of the mollusc, but at an angle to it of about 45°, the right ganglion being the more anterior of the two. Anteriorly both ganglia give off three or four nerves, but I have been unable to definitely

identify any of them, the nervous system not being decipherable in my serial sections. The two inner ones (*c.b.con.*) are believed to be the cerebro-buccal connectives. It is also believed that the labial circle described for *Nassopsis* by Moore (13) exists in this genus also, but this is entirely uncertain. A nerve rising from the posterior and inferior face of the right cerebral ganglion (*n.gen.*) often comes away with the ganglion. After running a rather short course it splits up into several fine branches. It has not been seen *in situ*, but possibly innervates the genitalia on the body wall. Inferiorly both cerebral ganglia are connected by their respective commissures (*c.pd.con.*) to the pedal ganglia. Posteriorly the cerebro-pleural commissures (*c.pl.con.*) are given off, and connect the cerebral and pleural ganglia. The left cerebro-pleural connective is longer than the right. The pleural ganglia (*pl.g.*) are also connected directly with the pedal ganglia, the pleuro-pedal connectives (*pl.pd.con.*) being stouter than the cerebro-pedal connectives.

The left pleural ganglion is connected directly with the sub-intestinal ganglion (*sb.int.g.*). Two other nerves arise from the left pleural ganglion; one of these (*dial.con.*) passes just under the floor of the body cavity in the direction of the left visceral nerve (*n.v.'*), with which, although it has not been traced so far, it possibly connects, causing a condition of dialoneury on the left side. The third nerve rising from this ganglion is probably the columellar nerve (*n.col.*). The right pleural ganglion, besides being connected to its fellow pedal and cerebral ganglia, is also connected by the supra-intestinal commissure (*sp.int.con.*) to the ganglion of that name (*sp.int.g.*). The supra-intestinal commissure is longer than is the subintestinal commissure. There are no nerves taking rise from the right pleural ganglion, so that there is no connection between that and the subintestinal ganglion. Both supra- and subintestinal ganglia give rise to the respective pallial (*n.pal.*) and visceral nerves (*n.v.*). The pedal ganglia (*pd.g.*), as in *Littorina*, are of a large size, and give rise inferiorly to numerous nerves, none of which have I been able to identify. A peculiar ganglionic knot (*p.g.k.*), partly divided from the

inward inferior face of each ganglion, and giving rise to two stout and two fine nerves, is worthy of note; they occur in *Littorina*, and are perhaps represented by slight swellings in the same situation on the pedal ganglia of *Nassopsis* (*vide* Moore, 13, pl. 20, f. 7).

Genitalia (♂) (fig. 3). The gland (fig. 3, *gl.*) is situated on the superior face of the visceral coil; its lobules are arranged around several centres, each centre apparently communicating with the vas deferens through one main canal. The vas deferens (fig. 3, *v.d.*) is situate on the axis of the coil, and is very much convoluted. Arrived at the anterior end of the liver it proceeds, parallel with the rectum, straight along the mantle; a little posterior to the anus it takes a sharp turn in towards the body, thence it continues, still as a closed vas deferens, along the body to the penis (fig. 3, *p.*). This is situated on the right side, almost under the snout. The seminal products pass through it, not along a groove on its side, as in *Littorina* (fig. 8).

Genitalia (♀) (fig. 4):—The gland, macroscopically, is the same as that of the male, except that it is larger and the centres of arrangement are not so distinguishable; some of the lobes extend round the outer side onto the inferior surface. The ovules (fig. 9) may be seen to be arranged around the edges of the lobules. The oviduct (fig. 4, *ovid.*) occupies the same position as the vas deferens, and is convoluted as much. The uterus (fig. 4, *ut.*) is placed on the mantle between the rectum and body; during fecundity it is much enlarged, and at such times the rectum lies in a groove on its inward side; at the posterior end, at the junction of the oviduct, there is a single convolution. Its walls are strengthened by muscular bands which may be seen from outside to form slight constrictions. From its anterior end, at the same position at which the vas deferens turns into the body, the uterus may be seen to give off a short tube, which opens into a groove (fig. 4, *ovip.*) running along the body; this groove terminates in the same situation as the penis, by its two walls dividing and becoming enlarged into flat attached lobes. Except during the period of fecundity, the whole of both the male and

female reproductive complex is very much shrunken, and the parts are very difficult to dissect out. At such times the glands are restricted to the main branches of the visceral arterial system, these branches forming the centres around which the lobes are grouped when fully developed. The extensions of the female gland around the outer side and on to the inferior face are invariably along the course of an artery. This variation in the size of the gland is noted by R. J. Harvey Gibson (5) in *Patella vulgata*; it doubtless occurs in all molluscs. I have myself noticed it in *Lotorium* and *Purpura*.

The peculiar form of the genitalia is the character on which it has been thought fit to found this family. In the male there is no sperm-groove as in *Littorina*, its place being taken by an anterior prolongation of the vas deferens; and, further, the seminal fluid passes *through* the penis, not along a groove on its side; nor are any glands to be detected on the penis. In the female we have an equally important difference—namely, the existence of an ovipositor (?) similar to that found in *Strombus* and *Pterocera*. The former of these differences is one of the most important anatomic differences between the Lotoriidæ and Muricidæ.

Moore has stated (12, p. 162) that he has found this ovipositor (?) slightly developed in *Littorina*. This is an observation that needs confirmation. The most careful examination of innumerable fresh and spirit specimens of *L. scabra*, Linn., (some of large size), and *L. mauritiana*, Lamk., has proved to the writer that it does not exist in either of these two species. Moreover, Souleyet (21), in his excellent account of the anatomy of *L. littorale*, Linn., does not mention its presence. If, therefore, it does exist in one species of so-called *Littorina*, I would suggest that species of two genera are grouped under one name.

Tenison-Woods (23) has stated that although the species of *Risella* are organically hemaphrodite, functionally the sexes are separate, and may be distinguished by the form of the shell. Both these statements are at variance with facts; it is probable that he mistook the ovipositor (?) for the male organ; of twenty

specimens, all exactly similar, of the form locally known as *R. plana*, Q. & G., nine were males and the remainder females.

Tryon's reference (24) of *Plesiotrochus*, Fischer (3), and *Limnotrochus*, Smith (20), to *Risella* as subgenera was altogether wide of the mark. Fischer's reference (4, p. 687) of the former to the Planaxidæ is much more likely to be correct. The systematic position of the latter has lately been ably discussed by Lettice Digby (2).

Risellopsis, Kesteven (9), is included here almost entirely on conchological characters, nothing beyond the operculum and dentition being known of its anatomy; amd on these it might equally be referred to the Littorinidæ.

The genus appeals to the writer as a perpetuation of the immature condition of *Risella* (*vide* fig. 11, pl. xxx.).

Modulidæ.

To this family, hitherto having but one genus—*Modulus*—I propose to add *Echinella*, Swainson, and *Peasiella*, Nevill (14). *Echinella* was proposed by Swainson (22) in 1840 for the reception of two species—*E. granulata*, Swains., and *E. coronaria*, Lamk. The former of these is apparently a *nomen nudum*, and has never, so far as I can ascertain, been identified. The latter has, therefore, been regarded as the type. Tryon (25, p. 231), *sub voce Tectarius* says:—"I am also compelled to unite with this group, as synonyms, *Nina*, Gray, 1850, and *Echinella*, Swainson, 1840, their characters being very variable, and shading into those of the type." Fischer (4) treated the genus as valid, placing it after *Tectarius*, in the Littorinidæ. He thus describes it:—"Coquille imperforée, granuleuse, épaisse; spire élevée, pyramidale; overture striée à l'intérieure; *base de le columelle muni d'une dent; opercule polygyré, à nucleus central.*" The italics are mine.

In arriving at the above conclusion, Tryon could only have studied the tooth on the base of the columella as the recognition mark of *Echinella*. This he would have found unreliable, since it is slightly developed in *Tectarius pagodus*, Linn. The more important character of the multispiral operculum was, in all

probability, entirely overlooked by him. Adams Brothers (1) enumerated three species of *Echinella*, viz. :—*E. coronaria*, Lamk. *E. granulata*, Swains., and *E. cumingii*, Phil. Although devoid of the tooth on the columella, *Tectarius spinulosus*, Philippi (17), has the multispiral operculum, and is, therefore, an *Echinella*. *Tectarius bullatus*, Martyn, and *T. tectum-persicum*, Linn., are probably referable here also. Tryon regards *E. coronaria*, Lamk., as a variety of the former of these two (25, p. 257), but it is doubtful whether this is correct; *T. spinulosus*, Phil., which he has stated to be the young of *T. bullatus*, Martyn, is certainly a distinct species. As stated by Hedley (8), *Tectarius montrouzieri*, Fischer, is a *Turcia*.

E. granulata, Swains., never having been identified, we have three species certainly belonging to the genus *Echinella*, with the probability of two others. *E. coronaria*, Lamk., doubtless has a polygyral operculum, and from personal knowledge the writer can say the other two have also. The opercula of several species of *Tectarius* have also been examined by the writer, and in no instance can he find an intermediate between the typically polygyral one of *E. cumingii* and that of *T. pagodus*, Linn., which is typically littorinoid.

In discussing the affinities of *Echinella*, the writer is handicapped in having been unable to obtain specimens for dissection. The operculum, however, happily affords us an important clue to its systematic position. Although undoubtedly bearing great conchological resemblance to *Tectarius*, the difference between their opercula debars their inclusion in the same family. There are only five or six families in the Tænioglossa in which the multispiral operculum occurs; of these the Modulidæ is the only one to which *Echinella* can be referred. The tooth on the base of the columella, possessed by some of the species, strengthens this classification, which, in view of our ignorance of the soft parts, is more advisable than would be the addition of another to the already large number of families in the suborder.

Peasiella was proposed by Nevill (14) as a subgenus of *Risella* for the reception of *Trochus tantillus*, Gould (6). His treatment

of it in this manner was apparently in deference to the opinion of E. A. Smith, who, in dealing with the type, had said:—"The interior of the aperture is not pearly as in the Trochidæ; and yet the operculum truly appertains to that family, being concentric and multispiral; and although, therefore, differing from that of *Risella*, the shell itself appears to suggest the propriety of its being located with that genus rather than with the Trochidæ" (19). Disregarding the peculiarly contradictory phrasing of this statement, the conclusion seems to be a good deal at fault. The resemblance of the shell to *Risella* is very slight, and, as stated, the opercula—characters of infinitely more importance—are of two distinct types. The dentition (Text fig. 1) resembles that of

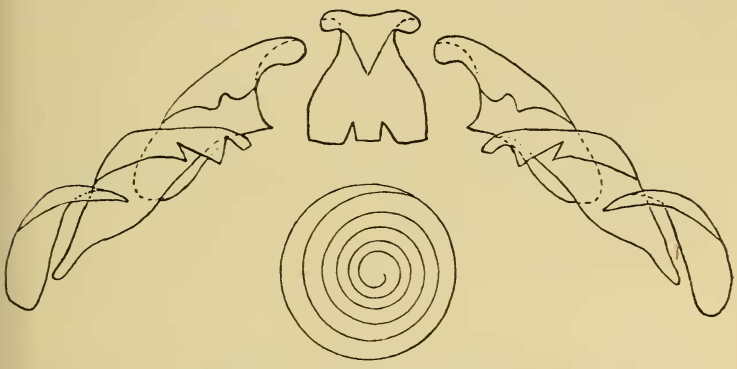

Fig. 1.—Operculum and dentition of *Peasiella tantillus*, Gould.

Littorina more nearly than any other; but that of *Modulus*, with which I would place *Peasiella* as a full and valid genus, is of the same type. The operculum also favours this allocation.

Hedley (8) has drawn attention to the fact that *Echinella gaidii*, Montrouzier (11), is a synonym of *Trochus conoidalis*, Pease (15). Montrouzier describes the operculum as normal—that is, corneous and multispiral, since such is the operculum of the genus to which he referred it. The species is, therefore, a *Peasiella;* but whether the other species which have been placed here (*vide* Tryon, 25, pp. 263-264) belong to this or distinct genera

remains to be ascertained, so insufficient have purely conchological characters proven.

Nassopsidæ.

The family here proposed contains but one species, *Nassopsis nassa*, Woodward (26, 27), one of the unique "Halolimnic" mollusca of Lake Tanganyika. The anatomy has been very thoroughly worked out by J. E. S. Moore (13), but this writer has viewed the characters of the species of the Halolimnic fauna from so prejudiced a standpoint that, instead of discussing their affinities, he has exerted all his ability to prove that they are surviving Jurassic archetypes. To such lengths is this conviction carried that the arguments used tend, in some instances, to weaken the undoubtedly correct theory that the lake has been an arm of the sea in early geologic times.

In the present instance no definite opinion as to the relationship of the genus is given, though it is vaguely compared with the Strombidæ, *Paludina* and *Littorina*. A careful weighing of its characters, however, it is here contended, shows its relationship to be with the Littorinidæ.

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EXPLANATION OF PLATE XXX.

Anatomy of *Risella*.

Fig. 1.—Digestive system.—*buc.*, buccal mass. *rad.*, radula. *an.*, anus. *m.gl.*, mucous gland. *post.œs.*, posterior œsophagus. *neph.*, nephridium. *liv.*, liver. *sal.gl.*, salivary glands. *crop*, crop. *r.b.o.*, reno-pallial orifice. *int.*, intestine. *h.-p.d.*, hepato-pancreatic ducts.

Fig. 2.—Circulatory system.—*cten.*, ctenidium. *br.v.*, branchial vein. *osph.*, osphradium. *neph.v.*, nephridial vein. *a.c.c.'c."c.'"*, branches of the posterior aorta. *b.*, right pallial artery. *ant.aor.*, anterior aorta. *neph.*, nephridium.

Fig. 3.—Genitalia (♂).—A., a spermatozooid. *p.*, penis. *v.d.*, vas deferens. *neph.*, nephridium. *gl.*, testes.

Fig. 4.—Genitalia (♀).—*ovip.*, ovipositor (?). *ut.*, uterus. *ovid.*, oviduct. *neph.*, nephridium. *gl.*, ovary. *r.p.o.*, reno-pericardial orifice.

Fig. 5.—Ctenidium.—*b.*, venous lacuna. *neph.v.*, nephridial vein. *vent.*, ventricle. *aur.*, auricle. *br.v.*, branchial vein.

Fig. 6.—Anterior portion of the digestive tract.—*buc.*, buccal mass. *sal.gl.*, left salivary gland. *app.*, left appendage. *ant.œs.*, anterior œsophagus. *crop*, crop. *post.œs.*, posterior œsophagus. *l.*, lumen. *rad.*, radula.

Fig. 7.—Rachidian tooth.

Fig. 8.—Penis showing sphincter muscles, and seminal canal squeezed out between lines of contraction.

Fig. 9.—One lobule of ovary showing ovules arranged round the edge.

Fig. 10.—Crop.—*l.*, lumen.

Fig. 11.—Young shell.

Fig. 12.—Nervous system dissected out and drawn with the camera lucida as seen floating in water.—*c.g.'*, left cerebral ganglion. *c.g.''*, right cerebral ganglion. *pl.g.'*, left pleural ganglion. *pl.g.''*, right pleural ganglion. *pd.g.'*, *pd.g.''*, left and right pedal ganglia, *sb.int.g.*, subintestinal ganglion. *sp.int.g.*, supra-intestinal ganglion. *sp.int.con.*, supra-intestinal connective. *sb.int.con.*, subintestinal connective. *c.pl.con.*, cerebropleural connectives. *c.pd.con.*, cerebro-pedal connectives. *pl.pd.con.*, pleuropedal connectives. *dial.con.*, dialoneurous connection (?) *c.b.con.*, cerebro-buccal connectives (?) *n.gen.*, genitalia nerve (?) *nv.'*, *n.v.''*, left and right visceral nerves. *n.pal.'*, *n.pal.''*, left and right pallial nerves. *n.col.*, columellar nerve (?) *p.g.k.*, ganglionic knots.

Fig. 13.—Nervous system seen from above. Lettering as in fig. 12.